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NASA's Voyager Fly-by Animations

Sean Cubitt

in Miriam Harris, Lilly Husbands and Paul Taberham (eds) Experimental Animation: From Analogue to Digital.
London: Routledge

A preliminary ambition of an eco-poetic approach to cinema is to establish that eco-criticism can give a radically new understanding of film and video. Part of the cultural work of experimental animation is to demand just such radically new readings. This chapter offers an eco-poetic/eco-critical reading of a group of films that appear to have no connection to environmentalism, and which are in every sense of the word experimental. In this sense the chapter is itself an experiment. As befits a philosophy of connection and interconnection, the eco-poetics of cinema has many genealogies. Among them, we should respect the genealogies of science and engineering that underpin the moving image in general and animation in particular, not least since it is in them that we first encounter the technique of experimentation. The rise of modern science in the Renaissance is a familiar story, perhaps too familiar and therefore unexamined (though see Koyré 1957 for an already more nuanced account). Science is composed not only of things known but someone or something who knows. For science to exist, it was first necessary to invent Man. In many respects, this is an invention that remains to be completed: indeed, its incompletion is surely a contributory feature in the notion of experimental media. The invention of the human that occupied the luminaries of the history of science and engineering – Galileo, Leonardo and Alberti among them – was conducted in a theological era, an era that lasted at least until the time of Newton. Yet our commonest narrative about the foundation of the scientific worldview is one of struggle with and escape from God. It might even be thought, in this tradition, that the struggle to secularise is integral to science and, like science itself, also unfinished. If science is incomplete, then the subject of science, the one who knows, is also still under construction. James Blinn's NASA animations of the Voyager space mission, coming at a particularly interesting moment in this history, are both experimental in their own right and accounts of an experiment in science and engineering in which the question of how the human can be extracted from the divine are particularly in play. To understand how this experiment contributes not only to space flight and space science but to the unfinished project of inventing the human, and by implication of distinguishing the human from a newly discrete 'nature', this chapter proposes to trace some of the missing theological genealogies of modern science. Animation constantly plays at the border of what it is to be human: Blinn's animations still reverberate as some of experimental animation's most moving expressions of what lies beyond the human., casting light on what the *anima* of animation might be. In religious or scientific form, or both intertwined in Blinn's animations, the very longing for transcendence evidences the intertwining of humanity with its environment, whose loss it at once demands and mourns.

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To define experiment in animation would risk losing its impetus. Yet the choice of 'experimental' rather than 'avant-garde' or 'artistic' as an adjective indicates a trajectory of work, one that attempts, tries out, explores and perhaps verifies an idea. It suggests an enquiry about what animation might achieve that it had not already, and perhaps about what kind of knowledge it might produce. The series of animations undertaken by James Blinn at the Jet Propulsion Laboratory (JPL) with Charles E. 'Charley' Kohlhase, Jr and the assistance of Alvy Ray Smith between 1978 and 1983 – when Blinn was awarded both the NASA Exceptional Service Medal and the SIGGRAPH Computer Graphics Achievement Award – surely merit the term, both for their development of then bran-new techniques in digital animation and for their application to one of the most daring engineering/science projects of its time. Several features make these short films (they circulated on 16mm) experimental.

Launched in 1977, the two Voyager spacecraft had yet to reach their first major planets, Jupiter and Saturn, when Blinn arrived at JPL from Ivan Sutherland's formative computer graphics program at the University of Utah. NASA engineers provided Blinn with the projected flight data which gave him the armature on which the animation would be built. In a 2014 interview, Kohlhase gave a sense of the complexity of these flight plans.

> 1977 was the 'Goldilocks' opportunity. In '76, since Jupiter is moving faster around the Sun than Saturn, it 'trails' Saturn, so to speak. You can still do a gravity assist on the trailing side of Jupiter, but you have to fly very close to get enough deflection to get to Saturn, which is further ahead. In '77 the arrangement was perfect for flying through the region of the Galilean satellites. . . . Then we wanted to fly by Io, which orbits Jupiter every 1.7 days, so we started dividing the encounter dates at Jupiter into 1.7-day increments. Titan goes around Saturn every 16 days, and we divided up the encounter at Saturn in this way too, but we also wanted to encounter Titan before we crossed the ring plane, rather than

> afterwards – we called these 'Titan-before' encounters. . . . we knew we could use "patched conics" – ellipses, parabolas, hyperbolas and so forth – to approximate the integrated trajectories, so we basically developed software that could approximate and run hundreds of cases overnight on a computer. We picked those which satisfied all engineering constraints, then asked the science teams which ones best suited their needs, for example close flybys of certain satellites. Finally, through this process, out of the 10,000 or so possible trajectories, we targeted 110 with the Titan-Centaur launch vehicle, and finally launched on two of them (Starr 2014).

Significantly, the trajectories plotted by the flight engineering team led by Kohlhase were projections, in the dual sense of projective geometries, especially in the case of the conic section geometry of the curved trajectory round planetary gravity wells, and in the sense that they projected the navigational trajectories forward in time. Accuracy in both modes of projection was essential, since each Voyager satellite carried only a tiny amount of fuel for course corrections, and an equally tiny 8Kb computer, mainly dedicated to the scientific mission rather than navigation: chances to fix launch errors were extremely limited. Mercifully, the calculations proved accurate: by the time of its 1989 encounter with Neptune's moon Triton, the error was of the order of one kilometre per billion. But at the time the animations were being done, the vast majority of the flight lay ahead. They are then exemplary of the deep principles of vector graphics: they indicate constantly changing direction over time extending into the future.

Equally significant is the application of data to the animation. While the computer-generated models of the Voyager craft were basically polygons of a kind already familiar in computer graphics, the orchestration of their movements was entirely derived from the geometry of Kohlhase's conics. The animating principle – the design of the motion – was then not the free, individual, creative act of the animator but a collaborative effort. In this, the animation is informed by and informs the collective subject of Science as the collective knower of scientific knowledge. Despite its dramatic setting, the films are by no means products of artistic fantasy: on the contrary, they are documentary in at least the sense that they document a complex engineering project, a certain kind of truth. In this, the fly-by animations are pre-cursors of CADCAM and architectural fly-throughs: intermediaries between a plan and its actualisation. Their order of truth is projection – here based on the escape velocity, direction of launch and interactions with heavenly bodies: predictable, within reason, but nonetheless an experiment. When we watch them today, we see the uncertain past of a now certain future that was still in the act of becoming. Where we see an actuality, Blinn, Kohlhase and their team could only descry potential.

This raises the unusual question – for animation – of realism. By the time the two Voyagers had completed their journey past the outer planets, the trajectories translated from flight planning data to animated flight had become real, and remain that way from that moment on. The trajectories have become real, in the sense that the projection has become a record of the two flights transcribed into animated film. For Blinn at his work desk, back in 1978, that real was not yet already actualised: it was the *idea* of the flight. In philosophical terms, this is a perfectly acceptable variant of realism. Opposed to 'nominalism', the theory that only particular objects exist, an older definition of 'realism' (rooted in mediaeval Scholasticism) proposed that the world is a presentation of underlying truths that do not make themselves apparent immediately (without mediation) to us humans. Ideas like Being, Truth, or for that matter conic sections are real, and our various media, as much as the phenomena of the world that we observe with our ordinary senses, are simply expressions of them. In the immense void of the space between Mars and the outer planets, the planned paths of the satellites existed only as idea. Yet by the Scholastic definition, that idea of the trajectory, with its complex gravitic slingshots, was already real. It was only a question of the animation expressing it, which it did before it was expressed a second time by the Voyager craft. Now that Voyager 1, hotly pursued by Voyager 2, is further from us than any human-made artefact has ever travelled, passing the demarcation line between the Solar System and interstellar space on the 25th of August 2012, it can no longer exist in any unmediated way for us left here on Earth. This was equally true of the period of their fly-bys of Jupiter and Saturn. They exist, therefore, not only as material objects whose speed and direction evidence their terrestrial origin, but as ideas made real. At the same time, unless you want to reach for some truly stupefying conspiracy theory, there is no reason to doubt that they are out there at the further reaches of the heliosphere, transmitting sporadic messages, and carrying with them the famous golden record in hopes of proving to some far-future alien species that we too once existed.

The golden record designed by Carl Sagan (with whom Blinn would collaborate on the successful TV mini-series *Cosmos: A Personal Voyage* [1980]) captured public attention and a degree of controversy. NASA's almost permanent funding crises have consistently driven them to media spectacles, from the 'Blue Marble' (Lazier 2011) and live pictures of the Moon landing to Hubble Space Telescope imaging of deep space (Chaisson 1994). The golden record was one such stunt, whatever its scientific purposes: a collection of greetings in 55 living and extinct languages, 115 images, 27 music and 21 other audio tracks, and a recording of brain activity on a pair of phonographic disks, one for each Voyager. The controversy came from the nude portraits of two strongly Caucasian figures, the male greeting, the female passive; and from the inclusion of Chuck Berry's *Johnny B. Goode* among the music tracks (Steve Martin joked that the first reply from the aliens would be 'Send more Chuck Berry'). Sagan's showmanship would be a major boost to NASA's popularity. The Voyager fly-by animations belonged to the same platform of popular appeal, over the heads of the government, directly to the taxpayers funding adventures in space.

Such, perhaps cynically, is one possible account of the rational for sending a phonographic disc into outer space. Alternatively, the determining factor of popular support in its turn enabled the Voyager animations to express the peculiar silence of digital animation which, unlike film, did not imply at the very least the chatter of a projector, and unlike analogue video of the period, is not simultaneously a sound-and-image medium. The silence of digital animation is more absolute than the absence of soundtrack on either film or video. It is entirely appropriate to the airless, vibrationless, soundless zone of interplanetary space. Once transferred to film, and of necessity (at least the necessity of professional practice in broadcast news) when transmitted, the animations acquired a soundtrack. In at least some instances, that soundtrack would have included samples from the golden discs. Which in turn begs the question: why send sound recordings into interstellar space? Recalling John Cage's experiments in the anechoic chamber, where in the depths of silence he heard the sounds of his breathing, his heartbeat, the blood rushing in his veins and finally the thin, high whine of his central nervous system, where there is a body there is no silence (Cage 1994). In deep space, there can be no body, for the same reason that there is no sound. To send sound is to evoke a body that is absent, left behind. There is a kind of congruence between the silent travel of discs full of sounds (themselves of course silent until some alien intelligence decodes the instructions on how to play them) and another delightful and thought-provoking quality of the animations, whose success with audiences and policy-makers as well as among the small but growing band of specialists in computer graphics was boosted by the inventively fluid camerawork of Alvy Ray Smith and his colleague David diFrancesco (Sito 2013: 49).

If the flight plans anchored the animation in maths, science and engineering, Smith's moves with the virtual camera introduced a choreography that transformed the mute documentation into a recognisably embodied experience. In his phenomenological study of *Bodies in Technology*, Don Ihde (2002: 58-60) recalls Galileo's experiments with the telescope, noting that though the astronomer and optician was focused on the objects he could observe – the surface of the Moon and later the moons of Jupiter – he might equally well have observed his own involuntary movements constantly reframing the remote objects as they pursued apparent their course through the turning sky. For Ihde this mutual approximation – movements of the body equated with the movements of its objects; bringing the Moon and the moons close to him and him closer to the Moon and the moons – is a permanent state of scientific observation. As a thermometer popped into boiling water changes the water's temperature in the act of measuring it, or even more like Einstein's observer on a moving train, all observation is necessarily relative, and therefore necessarily embodied. While modern science strives either to minimise or to incorporate this bodily presence, Smith's mobile views into the mathematical universe Blinn had built restores to it Ihde's sense of a human body engaged by and indecipherable from its observing.

The quasi-embodied state of quasi-phenomenological scientific instruments is implicit in the combination of flight plan and improvised camerawork. And yet the implicit body is not the familiar gravity-bound body of normal perception. Its strangeness blossoms in the evocation of zero gravity, a pleasurable vertigo like diving, the liberation of moving in three dimensions, while at the same time taking us into zones where no human could survive. The effect is of a non-human embodiment, an out-of-body embodiment, an intimation of posthumous existence that lays a gloss of spirituality over the hard engineering of the underlying data. That posthumous aura rhymes with the eternity of the Voyagers' flights into space beyond the Solar System and into time beyond the galaxy, a finite but barely conceivable duration played out in several fiction films including *Star Trek: The Motion Picture* (1979), where Voyager returns freighted with knowledge gathered through centuries of travel. Curiously, if the hard data gives a sense of the animated fly-bys as realist, these camera moves return them to nominalism. By specifying a view which is almost human, and whose motions emulate the processes of suture that stitch shots together in classical découpage (inviting us to want to see, and then supplying the view we wanted), these camera moves establish each of the satellites as a particular and unique object of perception. But at the same time, they instigate the same instability that gave realist theologians the basis for attacking nominalism. The virtual camera moves make clear that what we see are appearances, apart from the essential existence of the particular thing, so that as particular object, it fails the test of self-identity which, since Aristotle, has defined the being of being. The animation's realism produces the animated satellite as a symbol of something that exists as independent entity; superadding movement demonstrates that it is nonetheless both being and appearing, that it is inscribed in the field of the visible, and as such dependent on a universe in which, even in this posthumous or posthuman perspective, it is always there not only in its own right, but as object of perception, even if not to be perceived by humans; its mission not only to discover but to be discovered, not only to see but to be seen. Smith's moves on the one hand make it the object of human gazes – the millions of TV viewers in the USA and around the world – and at the same time of a more-than, less-than or other-than human perception in the cold, silent, weightless vacuum of outer space.

This weightlessness is an entirely appropriate evocation of Smith's three-dimensional camerawork, its swooping, circling, effortless and alluring vertigo. The embodiment of the camera implicit in its quasi-human perception of the satellites is at the same time an out-of-body experience. The camerawork takes the viewer from the domestic sitting room where she would ordinarily be watching the footage on the television set to an extreme of human perception which is both intensely mediated and, through its mobility, intensely present. At the same time, it de-domesticates the body, specifically the suburban (taken here to mean the level below the urban occupied by domestic space in urban environments), plugging it into the enormous capabilities of electronic networks that now, in 1978, extend beyond the terrestrial, beyond even the ionosphere that had formed part of radio technology since its wireless origins, to parts of the universe wholly inimical to human being, but now ostensibly immediately available to human vision. This distance from the domestic distinguishes the gendered body of the TV viewer circa 1978 from the genderless human body of the animated camerawork, incidentally also distinguishing it from the more presumptively gendered Man of the Renaissance origins of science and its project. The body of outer space is beyond biological sex, socio-cultural gender, affect and desire. Equally, while space explorations can easily be argued to be continuations of the imperial design of the Renaissance on cosmic scales, they are at least equally emblems, not of the settler, but of the refusal to remain indigenous to this little blue ball of Earth. These sacrifices of gendered and placed domesticity, on the other hand, like Galileo's telescope in Ihde's optic, allow the films simultaneously to extend the body to interstellar dimensions while bringing remote planets into physical reach. Much as we say that glamour is a function of the contradiction between apparent proximity and real distance (apparent intimacy combined with the irreducible distance between on-screen close-up and the viewer's body), so the Voyager fly-bys enact a profound contradiction between the graspable vertigo of Smith's roving point of view and the unutterable distance of the flight trajectories away from every familiar reference point barring a displaced, degendered, disembodied *idea* of the human.

The missions were tasked with sending back the first close-range imagery and data from the planets and their moons. Since, at this stage, there were no images, simulations of their likely appearances had to be provided by space artists Don Davis and Rick Sternbach (Starr 2014; for the significance of space art in special effects see Rehak 2015). Later, as the craft sped past the gas giants, NASA substituted actual imagery for the artists' impressions (Seymour 2012). The animations continued to evolve in line with the science. Blinn had however added something to the artists' impressions of the likely surfaces of these distant bodies: bump maps. Blinn introduced the technique of bump mapping in 1978. This involves altering the reflective properties ascribed to a smooth surface, without actually changing the surface itself, to give the impression that light is reflecting from it at a variety of angles, just as it would from a pitted surface. These apparent elevations and depressions, applied to the otherwise smooth spheres drawn by the artists from data caught by telescopes, gives the surfaces of the moons of Saturn and Jupiter the kind of texture that we expect from our knowledge of the Earth and the Moon.

As the flights progressed, the combination of artwork and bump maps were replaced with actual data from the spacecraft. The likely – the potential surface textures of the moons – was replaced by the actual, as observed by the satellites. Like the flight plans, the new data exists in the animation as metadata: as a scarcely visible alteration to the projections Blinn's team brought to the first purely animated versions, yet now carrying the weight of scientific measurement. This move from mediated projected to mediated instruments marks a move from realist to nominalist positions in the history of the fly-by animations as they developed from their first animated iterations to the newer versions incorporating the Voyager data. The supplement of the photographic observations of the outer planets and their moons added to the space art representations initially placed in the animations marks the arrival of knowledge sought and gained, the achievement of knowledge as the result of work. At the same time as it indicates the removal of the last traces of artistic fantasy, and with it of an older humanist individualism, replacement indicates both the unfinished quality of the experiment and its place as a process which involves both projection and labour.

At the beginnings of modern science lies the figure of Nicolas of Cusa, also known as Cusanus, theologian and mathematician (Cassirer 1963: 7-45). Cusanus set out to reconcile nominalism and realism through *docta ignorantia*, learned ignorance, whose founding principle was that 'the infinite, qua infinite, is unknown; for it escapes all comparative relation' (Cusa 1981 I, i : 3). Comparison was, for Cusanus, always a matter of measurement: of size, mass or distance. But in the realm of God, such measures are meaningless. On this principle, we cannot know God; but we can know what we can know: and therefore by discovering the limits of knowledge, come to understand where the Absolute, and therefore our ignorance, begins. The Voyager missions indicate the outer limit (c. 1977-83) of what might be known; beyond lies what Cusanus called the Absolute Maximum. This is the indefinite distance of the further galaxies (a secular infinity, a scale so vast that we cannot live long enough to know whether the Voyager craft ever make it there). But it marks also, critically, a sense that the unknown of space travel is also the infinite that has been left behind – not the human, which travels with it, but the planetary environment, and with it the fixed embodiment of our ordinary perception.

It is useful here to distinguish two complex terms whose evolution parallels much of the development of Western philosophy: *logos* and *nomos*. For the Scholastics immediately preceding Cusanus, *logos* recalled the first line of St John's Gospel, 'In the beginning was the word [*logos*])'. The word of God permeated His creation: this is the underlying principle of mediaeval 'realism' as belief in the reality of concepts. *Nomos*, the Greek for 'law', is also the principle of order, but order as a strictly human product, even if dedicated to and oriented towards God. The strictly algebraic flight data and its numerical expressions underpinning the animated spacecraft comprises the logic, the *logos* of the films; the 'handheld' camera the *nomos* that ties it to the regime of a human body. However, we should also add a more contemporary sense of *logos*. The ecological principle of the connectedness of everything with everything, is a theory of mediation. Everything connects through something; everything mediates. Grass mediates sunlight, cows mediate grass, humans mediate cows . . . We restrict the word 'media' to human and often only technological forms of mediation; yet for environmental thought, mediation is the universal principle. This thesis is itself a re-interpretation of the ancient Stoic philosophy of *logos* as the primal wisdom of the world. On the other hand, the severance of human from nature, and the restriction of mediation to human communication, which are themselves the foundation of law, of *nomos*, are also historical realities, indeed foundational of history as such, if we agree that history begins with the distinction of human from nature, and even more particularly with the conscious telling (that is communication) of history as stories and eventually written records. The challenge faced by Cusanus in reconciling realism and nominalism equates then to the more contemporary challenge of reconciling primal mediation as the *logos* of nature, and communicative *nomos* as the quality of the human.

In a first move, the animations reconcile the cardinal (counting) numbers used in constructing the polygon representations of the satellites and the real numbers used in vector graphics and the algorithms used to plot the trajectories (vectors) of the spacecraft, where 'real numbers' include the infinitesimals that lie between counting numbers (1.1, 1.12, 1.121, 1.1211111...). By including both polygon and vector graphics, the films reconcile not only two modes of depicting but two orders of mathematics, indeed two modes of infinity (the infinity of counting numbers lying at the end of the series 1,2,3,4...; but the infinity of infinitesimals always being as great between 1.1 and 1.2 as it is between 1.11111 and 1.11112). Because the Voyager expedition engages with the Absolute Maximum, it is only correct that its depiction should also establish the limits of its own capacities by introducing these ostensibly irreconcilable infinities in the medium itself. At the same time, through the addition of observed data, in numerical as well as photographic form, into the evolving pictures of the moons, the films also reconcile these Absolutes with the measurable realm. In a third moment, the videos then assimilate the human, in the form of the movements of the camera, to these disparate series and discrete modes of picturing,. The problem is however that this can only be achieved by abstracting all of these domains from the messy involvement of the ecological intermediation of everything. At this stage, we are still in the bind addressed by Cusanus: the restriction of knowledge to what can be quantified; to the exclusion of the green world that gave birth to, and still lies unreconciled with, the extreme technology of space flight. Save only that these voyages do involve and evoke worlds, even if not our own but the worlds Cusanus would have known as the Wandering Stars.

Labour, as already noted, is a feature of both the journey and the animations: labour is the necessary precondition for the production of the kind of knowledge that produces the documentary impulse of the project. It is important to clarify what is meant by labour here, since labour is a central category of materialist thought. This is not the indifferent, undifferentiated labour subsumed into exchange value at the heart of the commodity form: it is not itself the commodity form of labour. Rather this labour is the undertaking characteristic of humans (*homo faber*): to make and to pursue knowledge out of sheer curiosity. As Cassirer says of Cusanus,

> when he explains that all knowledge is nothing but the unfolding and explication of the complication that lies within the simple essence of the mind, he is referring not only to the basic concepts of logic, of mathematics, and of mathematical natural science [that is the innate knowledge that Socrates persuaded his interlocutors to reveal and the drive to compare through quantitative evaluation that Cusanus himself focused on], but also to the elements of technical knowledge and technical creation (Cassirer 1963: 57)

and as Cassirer continues to explain, Cusanus believes

> Because he is the representative of the universe and the essence of all its powers, man cannot be raised to the divine without simultaneously raising the rest of the universe by virtue of and within the process of man's own ascension. The redemption of man, therefore, does not signify his liberation from a world worthy of being left behind because it is the inferior realm of the senses. Rather, redemption now applies to the whole of being (Cassirer 1963: 64)

- a theme recognisable in Benjamin's *Concept of History*. The work of discovery is a labour of redemption; and though today we are less Platonic, no longer believing that basic syllogisms and the idea of number are born innate in the mind, those who were inspired by the animations were illuminated, however subliminally, by the mutuality of discovery: that the universe discovers the Voyagers and humanity as a condition of our discovery of the universe. That mutuality is precisely the secular redemption of the ecological movement. Equally significant, the labour involved is neither commodified nor productive of commodities. Presenting itself as pure science – as adventure, as imagination and as acquisition of knowledge without application – its labour is not a part of commodity relations but the goal of any work: to create wealth, of course, but not for its own sake: rather in order to discover the good, wherever it may lie. This is what wealth is for. To create art and science is in its way wasteful; but all social organisation is wasteful in the sense of requiring expenditure. Nor is this waste in the sense that warfare, the absolute waste of deliberate destruction, and the disposal of the detritus of consumption, structure waste as the integral principle of a capitalist system which requires this abjection of corpses, matter and environments in order to fuel its self-destructive compulsion to growth without end, endless over-production, which we now know to lead, ironically or cynically, to the end of all growth .

And yet there is no denying that from the point of view of human suffering and environmental degradation, the cost of these extraterrestrial adventures could have been deployed – better – in bettering the condition of humans on this planet. Its artistry, its status as art, then, belongs with the question of what human life is for, and so, theologically speaking, with the Four Last Things, the *quattuor novissima* of Death, Judgement, Hell and Heaven. Launching and depicting the Voyagers' voyages in this ambivalently posthuman way is the act of a species that already considers itself considers itself as if dead, and offers itself to eternity's judgement. It considers itself posthumously, in its silence and in the out-of-body embodiment of the virtual camera. Posthumous here implies not only the death of all life on Earth (or indeed its survival as the recipient of the heavenly return message from the future or the hell of a silent universe). The death that the Voyager project offers to survive is the death of consciousness. It is then the last act of a species which considers itself uniquely conscious in local space; and which nonetheless believes that somewhere, elsewhere, the universe will repeat the experiment of consciousness. The desire for infinity and the desire for posthumous existence are the theological ambitions of a secular age (It is almost possible Kohlhase, Blinn or Smith might have encountered Cusanus through their studies: Cassirer's book came out in English in 1963, early enough to have been available to their teachers if they ever took electives in History and Philosophy of Science).

The third book of the *docta ignorantia*, Cusanus' Christology, puts Christ at the crux between the measurable, comparable world of experience and the Absolute Maximum of Godhead. It is in Christ that we perceive the limit and the origin of the human. The same position in scientific modernism is occupied by the terrestrial ecology – the incomprehensibly complex which produces consciousness, and specifically the Voyager project and its expression as animation, as a purpose, a teleology: to understand consciousness's place in the universe. What results is not an absolute or maximal knowledge of the entire cosmos but more an understanding of our place in it, in line with Cusanus' belief that by discovering its own limits, the mind could intuit what lies beyond them. At the same time, since we are in the realm of the Last Things, it is also quite possible, in place of the deification of the scientific impulse, to read the whole project – satellites and animations – as an expression of shame at the failure of the species to ensure its own survival.

And yet, the Voyager mission does fulfil one posthumous action: to preserve the subject of science, the *concept* of humanity. Once again, the theological origins of the scientific project as a whole reveal something of what is at stake in this. In the opening narrative of his *Oration*, Pico della Mirandola describes the unique position of humans among the rest of creation:

> upon man, at the moment of his creation, God bestowed seeds pregnant with all possibilities, the germs of every form of life. Whichever of these a man shall cultivate, the same will mature and bear fruit in him. If vegetative, he will become a plant; if sensual, he will become brutish; if rational, he will reveal himself a heavenly being; if intellectual, he will be an angel and the son of God. And if, dissatisfied with the lot of all creatures, he should recollect himself into the center of his own unity, he will there, [having] become one spirit with God, in the solitary darkness of the Father, Who is set above all things, himself transcend all creatures. (Pico della Mirandola 1956: 8-9)

The key phrase here is 'the center of his own unity'. Pico sets humanism against pantheism, against all temptation to be swept into union with the *logos*, against all mystical dispersals of the self. For us, maintaining this self is no longer, as it was for Pico, necessarily about preserving a personal, individual subject. Instead, today, Science is the collective subject that knows, a subject which has gained through collaboration and socialisation but in the process sacrificed its gendered, placed and embodied position, transcending, as Pico suggested, his created nature. This subject, like Pico's 'Man', is however still engaged in the struggle to produce *nomos*, an order that would enable it to find the centre of its own unity, even if that order can only be achieved by alienating itself, in the form of this posthumous vision made so explicit in Blinn's animations, from the *logos*, the ecology that gives it birth. At the end of the Renaissance project to become human by knowing humanity, Voyager is the unhuman human at the edge of projection. It accepts, even embraces the cost of alienation from the world, precisely in order to overcome its self-alienation. For Pico, to be fully itself the human must transcend itself. To know, and thereby to be, humanity, science must sever its integration into nature. It is this severance that, in its structural absence, produces the tragic edge to the yearning expressed in the Voyager fly-by animations. At the same time, as Lucien Goldman describes Pascal's wager: 'Risk, possibility of failure, hope of success, and the synthesis of the three in a faith which is a wager are the essential constituent elements of the human condition' (Goldmann 1964: 302). This is the experiment at the heart of these animations: not simply to gamble on the success of the missions, but to bet that there is indeed a purpose to consciousness, to the consciousness which came to its concentrated peak between 1977 and 1983 in the science and engineering of the Voyager project and the computer graphics, still in their most experimental phase, that became their most iconic expression. Sending sounds into space is a pledge that somewhere, beyond the human and its extinction, there will be bodies to sense them; that there will be a body, and the environment (air, matter, vibration and therefore time) to support it. If in retrospect we re-apply Cusanus' principle of learned ignorance, we may well find the hubris and waste of the project is at least in part repaid by the discovery of what is revealed, in negative, by the documentary knowledge that the films became: that the human is defined not by its extinction in the vastness and duration of space but by the ecology that space flight by definition exiles it from.

ADDENDUM

In religious or scientific form, or both intertwined in Blinn's animations, the very longing for transcendence evidences the intertwining of humanity with its environment, whose loss it at once demands and mourns.

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